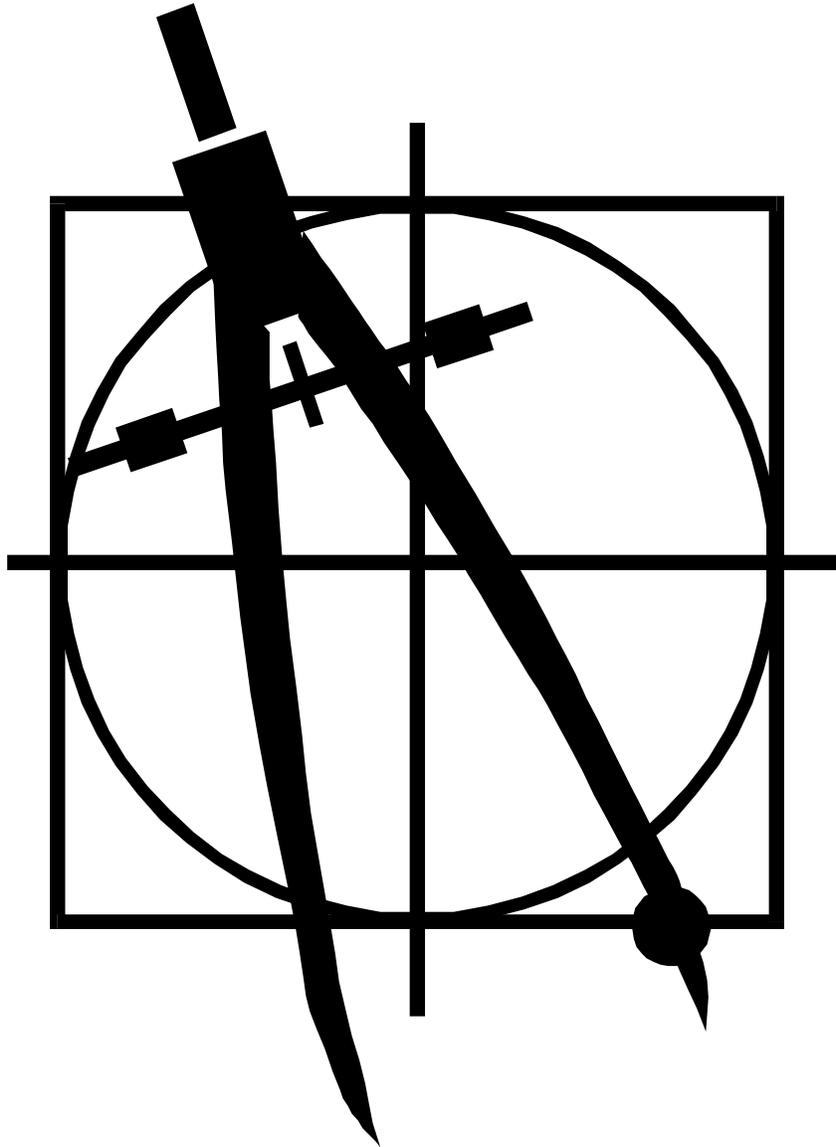


MECHANICAL EXHAUST VENTILATION SYSTEMS Design, Calculations, and Operational Guidelines



California Conference of Directors of Environmental Health

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TABLE OF CONTENTS

I.	Background	1
II.	Purpose and Scope	1
III.	Legal Authority and Applicable Codes and Standards	1
IV.	Definitions.....	2-3
V.	General Requirements	3-4
VI.	Exemptions From Providing Mechanical Exhaust Ventilation.....	4
VII.	Exhaust Hood Capacity Sizing	4-7
	A. <i>General requirements</i>	4-5
	B. <i>Minimum airflow calculations for canopy hoods</i>	5-6
	C. <i>Minimum airflow calculations for noncanopy hoods</i>	7
VIII.	Recommended Formulas For Specific Equipment	7-10
IX.	Grease Filters.....	10-12
X.	Exhaust Hood Ducting.....	12-14
XI.	Exhaust Hood Installation Requirements.....	14-15
XII.	Eye-Brow Hoods	15
XIII.	Water-Wash-Type Exhaust Hoods	15-16
XIV.	Recirculating Hood Systems (Ductless Hoods or Ventless Hoods).....	16
XV.	Make-up Air	16-17
XVI.	Fire Extinguishing Systems	17-18
XVII.	Ventilation Requirements For Special Cooking Equipment and Operations.....	18
	A. <i>Table-top cooking operations</i>	18
	B. <i>Table-side serving display operations</i>	18
	Appendix 1. Applicable Codes and Standards	19
	Appendix 2. Figures 1 through 7	20-27
	Attachment. Mechanical Exhaust Ventilation Systems-Operational Guidelines	

MECHANICAL EXHAUST VENTILATION SYSTEMS

Design, Calculations, and Operational Guidelines

California Conference of Directors of Environmental Health

I. Background

Proper venting and capture of the gases, heat, grease, vapors, and smoke generated by cooking equipment is important; not only for fire prevention and sanitation purposes, but also for maintaining the health and well being of food service workers. In order to help prevent dangerous or unhealthful conditions within a food facility, it is critical that exhaust ventilation systems be designed, constructed, and operated in compliance with all applicable requirements.

II. Purpose and Scope

- These guidelines are intended to assist in determining mechanical exhaust ventilation requirements for equipment that generates grease, vapors, fumes, smoke, steam, heat, and/or odors.
- Exhaust ventilation systems are also reviewed and inspected by local building and fire authorities to determine compliance with applicable building and fire codes.
- The requirements contained within this document represent minimum standards, which may be superseded by local ordinances. Where there is a contradiction in the requirements, the stricter should apply.
- Due to the differing roles of the local enforcement agencies and local building departments not all health jurisdictions will be applying all portions of these guidelines.

III. Legal Authority and Applicable Codes and Standards

- A. California Uniform Retail Food Facilities Law, Section 114140.
- B. California Code of Regulations, Title 17, Article 10.4, Commencing with Section 13670.
- C. California Code of Regulations, Title 24, Part 4, Chapter 4-20, commencing with Section 4-2000.
- D. Applicable Codes and Standards (refer to Appendix 1).

IV. Definitions

- A. *Canopy Hood* – a hood designed so the inside edge overhangs or extends a horizontal distance not less than six inches beyond the outer edges of the cooking surface.
- B. *Compensating Hood* – a hood designed to introduce outside make-up air through an integrated section of the hood with little or no thermal conditioning. This design will typically provide 60-80% of the required make-up air through four basic discharge methods: short-circuit, face-discharge, back-discharge, and down-discharge. These methods may also be combined, such as a face and down-discharge arrangement.
- C. *Convection Oven* – a gas or electric heated oven that uses a fan or blower to recirculate the heat throughout the interior of the oven.
- D. *Ducting* – the conduit that is used to convey exhausted air from the exhaust hood to the outside of the food facility.
- E. *Grease Extractor* – a series of baffles installed in the exhaust hood in such a way as to remove grease from the exhausted air using centrifugal force.
- F. *Grease Filter* – a device that is installed in the exhaust hood in such a way as to remove grease from the exhausted air by entrapment, impingement, adhesion, or other similar means.
- G. *Hood* – an air-intake device connected to a mechanical exhaust ventilation system for collecting and removing cooking effluent which contains grease, vapors, fumes, smoke, steam, heat, or odors which are generated by cooking equipment and warewashing machines.
- H. *Listed Equipment* – equipment and materials which, following evaluation and acceptance by a qualified testing agency, are placed on a list of certification. The listing shows that the equipment and materials comply with accepted national standards, which have been approved or evaluated for conformity with approved, or national standards.
- I. *Noncanopy Hood* – a hood that does not extend completely over the cooking equipment. A noncanopy hood is designed to be as close as possible to the cooking surface, usually 18 to 24 inches above it.
- J. *Plenum* – an air compartment or chamber to which one or more ducts are connected and which forms part of the supply-air, return-air, or exhaust air system.
- K. *Portable* – equipment having the properties of being portable, weighing less than 80 pounds, not exceeding three feet in any plane, and having utility connections

designed to be disconnected or of sufficient length to permit equipment movement for cleaning.

- L. *Recirculating Hood System (Ductless hoods or Ventless hoods)* – a self-contained air exhaust system that removes grease, vapors, fumes, smoke, steam, and odors from the exhausted air; and then reintroduces the filtered air back into the food facility. The grease, vapors, fumes, smoke, and steam are normally removed using a variety of systems such as water sprays, electrostatic precipitators, or multiple filter banks. The odors are typically removed using activated charcoal filters. Recirculating hood systems are not designed to eliminate heat from the exhausted air. Recirculating hood systems are also known as ductless or ventless hoods.
- M. *Type I Exhaust Hood* – a hood that is designed to collect and remove all types of cooking effluent from the exhausted air.
- N. *Type II Exhaust Hood* – a hood that is designed to collect and remove **only** steam, vapors, heat, or odors.
- O. *Water-Wash-Type Exhaust Hood* – a Type I hood which uses water to remove accumulated grease from the grease extractors.

V. General Requirements

- A. Section 114140 of CURFFL states in part, “Ventilation shall be provided to remove toxic gases, heat, grease, vapors, and smoke from the food establishment. All areas shall have sufficient ventilation to facilitate proper food storage and to provide a reasonable condition of comfort for each employee, consistent with the job performed by the employee. On or after January 1, 1985, there shall be provided mechanical exhaust ventilation at or above all newly installed cooking equipment as required in Article 10.4 (commencing with Section 13670) of Title 17 of, and Chapter 4-20 (commencing with Section 4-2000) of Part 4 of Title 24, of the California Code of Regulations. “
- B. The Uniform Mechanical Code states, “Hoods shall be installed at or above all commercial-type deep fat fryers, broilers, fry grills, steam-jacketed kettles, hot-top ranges, ovens, barbecues, rotisseries, dishwashing machines and similar equipment which produce comparable amounts of steam, smoke, grease or heat in a food-processing establishment. For the purpose of this section, a food-processing establishment shall include any building or portion thereof used for the processing of food but shall not include a dwelling unit.”
- C. Listed ventilation equipment shall be installed and used according to the manufacturer’s installation and operating instructions. A copy of the instructions

shall be readily available for review by the enforcement officer. Nonlisted ventilation equipment, when approved by the authority having jurisdiction, shall be constructed, installed and used in accordance with all applicable requirements contained in the codes identified in Appendix I of these guidelines.

- D. Exhaust ventilation systems shall conform to all local building and fire codes and have all necessary approvals from the local building and fire authorities.

VI. Exemptions From Providing Mechanical Exhaust Ventilation

- A. Section 114140 of CURFFL also states, "This section shall not apply to cooking equipment when such equipment has been submitted to the department for evaluation, and it has found that the equipment does not produce toxic gases, smoke, grease, vapors, or heat when operated under conditions recommended by the manufacturer. The department may recognize a testing organization to perform any necessary evaluations." In this case, the department means California Department of Health Services.

Note: Local building and fire authorities may still require mechanical exhaust ventilation over equipment exempted by the department.

- B. Refer to items marked with an asterisk in Section VIII of this document for examples of recommended equipment exemptions.

VII. Exhaust Hood Capacity Sizing

A. General requirements

1. Hoods that have been evaluated and listed shall be sized and installed in accordance with the terms of their listing and according to the manufacturer's instructions.
2. Type I hoods for use over charcoal and other solid-fuel charbroilers shall be provided with separate exhaust systems (e.g., separate exhaust duct and exhaust fan).
3. When different types of cooking equipment are installed under a common hood, the entire hood shall be designed using the formula that produces the highest flow rate. For example, a single hood installed over a gas charbroiler, fryer, and range, shall be designed using the formula for the charbroiler (Formula 1).

4. When cooking equipment is installed back to back and is covered by a common island-type hood, the minimum airflow required may be calculated using the formula for three sides exposed.
5. In sizing exhaust hood airflow, the formulas are intended to meet the needs of most installations. Due to variables at each installation site, such as cross currents, alterations may be required in order to provide an exhaust system which properly removes the cooking effluent from the kitchen.

B. *Minimum airflow calculations for canopy hoods*

The Uniform Mechanical Code separates cooking equipment into the following four categories for the purpose of calculating minimum required withdrawal airflow:

1. *Key to formulas*

A = The horizontal surface area of the hood, in square feet.

D = The distance, in feet, between the lower lip of the hood and the cooking surface.

P = That part of the perimeter of the hood that is open, in feet.

Q = Quantity of air in cubic feet per minute (CFM).

2. **Formula 1**

For Type I hoods located above solid-fuel cooking equipment and grease-burning charbroilers.

<u>Number of Exposed Sides</u>	<u>Formula</u>
4 (island or central hood)	$Q=300A$
3 or less	$Q=200A$
Alternate formula	$Q=100PD$

3. **Formula 2**

For Type I hoods located above high-temperature cooking equipment, such as deep-fat fryers and woks.

<u>Number of Exposed Sides</u>	<u>Formula</u>
4 (island or central hood)	$Q=150A$
3 or less	$Q=100A$
Alternate formula	$Q=100PD$

4. **Formula 3**

For Type I hoods located above medium-temperature cooking equipment, such as rotisseries, grills, ranges.

<u>Number of Exposed Sides</u>	<u>Formula</u>
4 (island or central hood)	$Q=100A$
3 or less	$Q=75A$
Alternate formula	$Q=50PD$

5. **Formula 4**

For Type I hoods located above low-temperature cooking equipment, such as medium-to-low-temperature ranges, roasters, roasting ovens, and pastry ovens. This formula is also used for Type II hoods located above nongrease generating equipment, such as high-temperature dish machines.

<u>Number of Exposed Sides</u>	<u>Formula</u>
4 (island or central hood)	$Q=75A$
3 or less	$Q=50A$
Alternate formula	$Q=50PD$

6. *Examples*

The following two examples will demonstrate the use of the hood sizing formulas for canopy hoods.

For these examples, we will use the dimensions provided in Figures 1 and 2.

a. *In the first example, we will assume that all of the cooking equipment under the hood is of the medium-temperature category. Therefore, we will use formula 3.*

Since there are three exposed sides, the first formula we will use is $Q=75A$.

The area (A) is obtained by multiplying the length times the width;
 $12 \text{ ft.} \times 4 \text{ ft.} = 48 \text{ sq. ft.}$

This A value is then inserted into the $Q=75A$ formula; $Q=75 \times 48$;
 $Q=3,600 \text{ CFM.}$

Therefore, a minimum of 3,600-CFM airflow would be required for this particular hood.

b. *In the second example, we will use the same dimensions and cooking equipment as in the first example. However, this time we will use the alternate formula, $Q=50PD$.*

The P in this example is obtained by adding together the length and width dimensions for the exposed sides, $4 \text{ ft.} + 12 \text{ ft.} + 4 \text{ ft.} = 20 \text{ ft.}$

The D in this example is 4 ft.

By inserting these figures into the formula we obtain the required CFM;

$Q=50 \times 20 \times 4$; $Q=4,000 \text{ CFM.}$

Therefore, using the alternate formula, a minimum airflow of 4,000 CFM would be required for this hood.

C. *Minimum airflow calculations for noncanopy hoods*

The volume of air exhausting through a noncanopy hood to the duct system shall not be less than 300 CFM per linear foot of cooking equipment. The formula to use when determining the minimum airflow for a noncanopy hood is $Q=300 L$.

1. *Key to the formula*

Q=Quantity of air in CFM

L=Linear footage of the cooking equipment.

2. *Example*

The following example will demonstrate the use of the hood sizing formula for noncanopy hoods.

For this example we will use the dimensions provided in Figure 3.

The lineal footage of cooking equipment is given as 12 feet. By inserting the 12 feet into the formula for noncanopy hoods, $Q=300 L$, we get $Q=300 \times 12$; $Q=3,600$ CFM.

Therefore, this hood requires a minimum airflow of 3,600 CFM

Note: In designing kitchen exhaust systems, designers must determine the resistance to airflow (static pressure) that is inherent in every system. By doing so, properly sized fans and motors may be selected. This will result in a quieter, smoother operating, and more efficient system.

VIII. **Recommended Formulas for Specific Equipment**

<u>Equipment</u>	<u>Hood Type</u>	<u>Formula To Use</u>
Bain Marie	II	4
Barbecue (solid fuel, e.g., wood or charcoal)	I+	1
Broiler (Gyro)	I	3
Charbroiler		
• Underfired (solid fuel or gas-fired, including radiant units)	I+	1
• Overfired or salamander	I	1
• Underfired (electric)	I	3
Cheese Melter (top browning and melting only)	II	4
Chinese Range (wok)	I	2
Coffee Equipment		
• Urn or brewer	*	—
• Roaster (gas)	II	4
• Roaster (electric)	*	—

Corn on the Cob Warmer	*	—
Crepe Maker		
• Portable	*	—
• Nonportable	II	4
Deep Fat Fryer	I	2
Dishwashing Machine		
• High temperature	II	4
• Chemical sanitizing or any undercounter unit	*	—
Griddle, Grooved Griddle or Grill	I	3
Hot Dog Warmer	*	—
Hot Plate		
• Electric (one burner only)	*	—
• Gas (Maximum of 5,000 BTU's)	*	—
• Multiple hot plates or larger than exempted units	I	3
Kettle (steam jacketed)	II	4
Kettle (candy)	II	4
Masa Cookers	II	4
Ovens		
• Maximum temp. of 250°F (thermostatically controlled)	*	—
• Gas or electric, greater than 250°F, <u>without grease vapor generation</u> (such as enclosed ovens for baking pizza and bread products only)	II	4
• Gas or electric, greater than 250°F, <u>with grease vapor generation</u> (such as conveyor pizza ovens, roasting ovens, and rotisseries)	I	3
• Portable ovens (microwave, cook and hold)	*	—
• Solid fuel-fired pizza and baking ovens	I+	4
• Tandoor Oven (solid fuel or gas-fired)	I+	1
• Combi Oven	I	3
Popcorn Popper		
• Without external grease vapor release	*	—
• With external grease vapor release	I	3
Pressure Fryer	I	2
Range		
• High temp, e.g., "hot tops"	I	2
• All others	I	3

Rethermalizer		
• Without external grease vapor release	II	4
• With external grease vapor release	I	3
Rice Cookers		
• Electric	*	—
• Gas	II	4
Rotisserie		
• Open or high temp	I	3
• Enclosed with max. ambient cavity temperature of 250°F	*	—
Skillet (tilting or braising)	I	2
Steam Cooker	II	4
Steam Table (hot holding only)	*	—
Toaster (bread only)		
• Portable	*	—
• Nonportable	II	4
Waffle Cone Maker / Waffle Iron		
• Portable	*	—
• Nonportable	II	4

+ Cooking equipment that uses solid fuel must be provided with a separate exhaust system.

* Equipment marked with an asterisk typically does not need mechanical exhaust ventilation. However, the following criteria should be taken into consideration when determining the need for mechanical exhaust ventilation:

- Installation of other unventilated heat generating equipment in the same area, e.g., refrigeration condensers, steam tables, or counter-top equipment;
- Presence of heating/cooling (HVAC) system;
- Size of the room or area where the proposed equipment will be installed, including ceiling height;
- How the proposed equipment will be operated, e.g., the types of food prepared, how often, etc.;
- Relative size of the proposed equipment, e.g., physical size and weight, BTU's/
- Nature of the emissions, e.g., grease, heat, steam, etc.;
- Temperature at which the proposed equipment operates. Cooking equipment that has a factory-set thermostat that cannot exceed 250°F normally does not need mechanical exhaust ventilation;

- Method of producing heat, e.g., gas, electricity, solid fuel, etc.

IX. Grease Filters

- A. Grease filters are designed to remove grease particles from the exhaust air stream. Exhaust systems that have broken, missing, or undersized filters are prone to collect accumulations of highly combustible grease deposits throughout the entire duct system. Because of the chimney effect created in vertical ductwork, a very intense rapidly spreading flash fire can engulf the entire system.
- B. Type I hoods shall be equipped with approved grease filters or grease extractors designed to remove grease from the exhausted air.
- C. The most common grease filters currently in use are the baffle-type. Baffle-type filters simplify the cleaning process since most of the grease deposits run off the baffles to a collection device. The old style mesh-type filters are not acceptable in new installations. NFPA 96, ANSI NSF Standard 2, and UL 1046 no longer recognize the old style mesh type filters. They may present a fire hazard and decrease airflow as they become clogged with grease.
- D. Grease filters and extractors shall be of such size, type, and arrangement as will permit the required quantity of air to pass through such units at rates not exceeding those for which the filter or extractor was designed and approved. The optimum operating velocities, measured in feet per minute (FPM), vary from filter to filter. Therefore, the manufacturer's specifications should be consulted to obtain the appropriate rates for each specific filter.
- E. *Number of Filters Required*
1. It is important to select the proper number of grease filters for the hood. Too few filters increase the resistance to airflow and raise the filter cleaning frequency.
 2. The minimum required number of filters for a particular hood can be calculated by dividing the total volume of air to be exhausted, in CFM, by the optimum operating velocity of the filter, in FPM. This number is then divided by the actual square footage of the filter (excluding the frame). The resulting figure represents the minimum number of filters required to efficiently remove the grease from the exhausted air.

Example:

Assume the following:

- An exhaust hood with a minimum required airflow of 3,250 CFM.

- Baffle type filters with a nominal size of 16" x 20", have an actual filtering surface of 14" x 18". (Nominal size minus the frame equals the actual filtering area.)
- An optimum operating velocity of 360 FPM for the filter.

$$\frac{\text{Volume of Air Exhausted}}{\text{Operating Velocity of Filter(FPM)}} = \text{Filter Area Needed (sq. ft.)}$$

$$\frac{3,250 \text{ CFM}}{360 \text{ FPM}} = 9 \text{ sq. ft.}$$

Next, convert the actual filter area to square feet:

$$14 \text{ in.} \times 18 \text{ in.} = 252 \text{ sq. in.}$$

$$\frac{252 \text{ sq. in.}}{144 \text{ sq. in./sq. ft.}} = 1.75 \text{ sq. ft.}$$

Then divide the 9-sq. ft. of needed filter area by sq. ft. per filter:

$$\frac{9 \text{ sq. ft.}}{1.75 \text{ sq. ft.}} = 5 \text{ filters}$$

Therefore, in this example, 5 filters would be required to provide adequate removal of the grease.

- F. Any space in the hood not occupied by a filter should be blanked off with sheet metal. Blanks may be placed above nongrease producing equipment such as a steam table, in order to achieve a better draw where it is needed the most. As much as possible, the blanks should be divided equally between the filters. This will ensure optimum performance and will equalize the air velocity over the entire length of the hood opening.
- G. It is important to install filters at the ends of the hood. However, grease filters should not be installed directly over a broiler flue, or any other flue from cooking equipment. Hot gases can make the filters very difficult to clean and may damage them.
- H. The minimum distance between the lowest edge of a grease filter and the actual cooking surfaces shall be as follows:

<u>Type of Cooking</u>	<u>Minimum Separation Required</u>
No exposed flame grills, french fryers, etc.	2 feet
Exposed flame and burners	2 feet
Exposed charcoal and charbroiler-type fires	3 1/2 feet

- I. Filters shall be installed at an angle not less than 45 degrees from the horizontal and shall be equipped with a drip tray beneath the lower edge of the filter. This enables the grease to be collected in the drip tray and avoids grease dripping into food, or on food preparation surfaces.
- J. All grease collecting equipment shall be accessible for cleaning. Filter units shall be installed in frames or holders with handles so as to be readily removable without the use of tools, except where the system is designed for in-place cleaning.
- K. Proper hood design will keep the temperature at the filters less than 200° Fahrenheit. When the temperature at the filters is less than 200° Fahrenheit, the grease deposits will be brownish in color and can be easily removed. When the temperature exceeds 200° Fahrenheit, the grease deposits tend to bake on the filters. The color of the deposits will darken and become extremely difficult to remove.
- L. Filter equipped exhaust systems shall not be operated with damaged or missing filters.

X. Exhaust Hood Ducting

- A. A separate duct system shall be provided for each Type I hood, except that a single duct system may serve more than one hood located in the same story of the building, provided that all hoods served by the system shall be located in the same room or adjoining rooms.
- B. Ducting shall be installed in compliance with local building and fire codes.
- C. Exhaust ducts from hoods shall be totally separated from all other ventilation systems.
- D. If the hood length exceeds 12 feet, it is necessary to provide two discharge ducts from the top of the hood to the main exhaust duct. For listed hoods, refer to the manufacturer's installation and operating conditions to determine if a distance of greater than 12 feet between ducts is permitted.
- E. Exhaust outlets for the exhaust hood ducting shall extend through the roof unless otherwise approved by the local building official. Such extension shall be at least 24 inches above the roof surface; at least ten feet from an adjacent building, adjacent property line, or air intake into any building; and shall be located at least ten feet above the adjoining grade level. However, exhaust outlets for ducting may terminate at least five feet from an adjacent building, adjacent property line, or air intake into a building if the air from the exhaust outlet is discharged away from such locations.

Exhaust air may be reintroduced into the food establishment only through a properly designed and approved air recovery system, such as a ductless hood system.

- F. Exposed duct systems serving a Type I hood shall have a clearance of at least 18 inches from unprotected combustible construction. This clearance may be reduced to not less than three inches, provided the combustible construction is protected with material required for one-hour fire-resistive construction. Hoods less than 12 inches from the ceiling or wall, including the space between the duct and the duct shaft, shall be flashed solidly. Flashing shall be of either the same materials used in the construction of the hood, or of other materials conforming to one-hour fire-resistive construction. Check with your local building and fire authorities to determine other acceptable means of meeting this requirement.
- G. Duct systems serving a Type I hood shall be designed and installed in a manner to provide an air velocity within the duct system of not less than 1,500 FPM and not to exceed 2,500 FPM. The optimum duct velocity is 2,000 FPM.

H. *Duct Sizing*

1. The duct leading from the exhaust hood to the exhaust outlet shall be sized correctly. The velocity of the exhaust air shall be high enough to minimize condensation on the various parts of the duct system.
2. The following formula shall be used to determine the correct duct size:

$$\frac{\text{Volume of air exhausted (CFM)}}{\text{Duct Velocity (FPM)}} = \text{Duct area needed (sq. ft.)}$$

In an example of this calculation we will assume the following:

- An exhaust hood with a minimum required airflow of 3,600 CFM.
- A duct velocity of 2,000 FPM.

By inserting this data into the formula we will obtain the required duct size:

$$\frac{3,600 \text{ CFM}}{2,000 \text{ FPM}} = 1.8 \text{ sq. ft.}$$

- I. A circular duct requires a smaller space. If rectangular ducts are used, they should be as nearly square as possible.
- J. The duct take-off at the top of the hood should be transitioned. This will reduce the entrance loss and resistance offered to airflow at the ducting entrance point.
- K. The bends and elbows of the ductwork should be kept at a minimum. When elbows are used, a radius of 2 to 2 1/2 times the duct diameter is recommended. This will minimize the resistance against which the blower must move the air.
- L. Duct systems serving a Type I hood shall be constructed and installed so that grease will not collect in any portion of the ducting. The ducting shall slope not less

than 1/4 inch per linear foot toward the hood or toward an approved grease reservoir. Where horizontal ducts exceed 75 feet in length, the slope shall be not less than one inch per linear foot.

- M. Any portion of the ducting that is inaccessible from the duct entry or discharge shall be provided with cleanout openings. Cleanout openings shall be equipped with tight fitting doors that are constructed of the same material and thickness as the ducting. The doors shall be equipped with latches that will hold the door tightly closed. Doors shall be designed so that they can be opened without the use of tools.
- N. Ducts and plenums shall be constructed of carbon steel not less than .055 inch (No. 16 gage), or stainless steel not less than .044 inch (No. 18 gage) in thickness.
- O. All seams and joints shall have a liquid-tight, continuous external weld.
- P. All ducting that is exposed to the outside atmosphere and subject to corrosion shall be protected against such corrosion. Galvanization of metal parts, protection with noncorrosive paints, or installation of waterproof insulation are acceptable methods of protection.

XI. Exhaust Hood Installation Requirements

- A. Canopy hoods must overhang, or extend a horizontal distance of at least 6 inches beyond the outer edge of the cooking surfaces on all open sides. This distance is to be measured from the inside lip of the hood.
Note: The minimum six-inch overhang may not be sufficient to capture all of the smoke, vapors, or grease generated by some cooking equipment. A 12-18 inch overhang is recommended for large or stacked ovens, conventional steamers, large tilting kettles, and bain maries. A 12-18 inch overhang at the side of the hood is also recommended for charbroilers when the equipment is located at the end of the cookline. (The minimum recommended overhang around the perimeter of an island hood installed over solid fuel cooking equipment is 12 inches.)
- B. The vertical distance between the lower lip of the hood and the cooking surface shall not exceed 4 feet.
- C. Every portion of a Type I hood shall have a clearance from combustible construction of not less than 18 inches. This clearance may be reduced to not less than three inches, provided the combustible material is protected with materials as specified for one-hour fire-resistive construction on the hood side.
- D. Canopy hoods shall be flashed to the ceiling and adjacent walls. The flashing shall be constructed of the same material and thickness as the hood. ***See Figures 4 and 5 for illustrations of the flashing methods.***

- E. Exhaust hoods shall be constructed of galvanized steel, stainless steel, or copper in compliance with the Uniform Mechanical Code.
- F. All joints and seams shall be liquid-tight and smooth for ease of cleaning. Approved construction methods and materials shall be used for sealing joints and seams.
- G. Pop rivets, metal screws, or other similar exposed fasteners shall not be used on the internal surfaces of a hood.
- H. Every hood shall be securely fastened in place by noncombustible supports. Exposed support hangers shall be of an easily cleanable design and construction. Threaded rods and chains are not acceptable.
- I. All conduit and fire protection piping shall be installed outside the hood, except for conduit or fire protection piping that leads from outside the hood directly to approved lighting fixtures or fire protection nozzles located inside the hood. All conduit or piping installed inside the hood shall be installed at least 3/4 inch away from the hood surface to facilitate cleaning.
- J. Light fixtures installed inside exhaust hoods shall be marked, "For use within commercial cooking hoods", or equivalent.

XII. Eye-Brow Hoods

- A. Eye-brow hoods are acceptable for use with either Type I or Type II hoods.
- B. The minimum required airflow shall be calculated using the formula for noncanopy-type hoods, i.e., $Q = 300L$.
- C. The eye-brow hood shall overhang, or extend a horizontal distance of at least six inches, beyond all areas of the equipment out of which steam, grease, odors, smoke, or heat will be emitted. **See Figures 6 and 7 for examples of this type of installation.**

Note: The minimum six inch overhang may not be sufficient to capture all of the smoke, vapors, or grease generated by some cooking equipment. A 12-18 inch overhang is recommended for large or stacked ovens, conventional steamers, large tilting kettles, and bain maries.
- D. When eye-brow hoods are equipped with grease filters or grease extractors, the filters or extractors shall be readily accessible for cleaning and servicing.

XIII. Water-Wash-Type Exhaust Hoods

- A. Water-wash-type hoods operate under the following principles: As the exhausted air moves at a high velocity past a baffle system, the heavier-than-air particles of

grease are thrown out of the airstream by centrifugal force. The extracted grease is collected in grease gutters within the hood until removed by the daily cleaning cycle. The cleaning cycle is initiated when the exhaust hood is turned off. Hot detergent water is automatically sprayed onto the baffle system, thereby removing the grease deposits from the baffles. This wastewater is then drained off to the sewer or other approved waste removal system.

- B. In order to protect the potable water supply, an approved backflow prevention device, such as a reduced pressure principle device (RP device), is required to be installed on the water inlet pipe, prior to the detergent pump solenoid.
- C. The wastewater from a water-wash-type hood shall be drained through an air gap separation into an approved receptacle, such as a floor sink.

XIV. Recirculating Hood Systems (Ductless hoods or Ventless hoods)

- A. Where it is not possible to exhaust the air to the out-of-doors, a nonducted, self-contained exhaust system may be a viable option for the food establishment.
- B. Gas cooking equipment, when approved by the authority having jurisdiction, may only be installed below those hoods that are equipped to remove combustion by-products.
- C. The cooking equipment and exhaust system shall be interlocked such that when the hood is not functional or when the hood is operating at less than 85% efficiency, the cooking equipment will not operate.
- D. An approved backflow prevention device shall be installed when potable water is plumbed to the hood system, e.g., on the water inlet pipe, prior to the water pump solenoid. The wastewater from the scrubbing operation shall be drained through an air gap separation into an approved receptacle, such as a floor sink.
- E. Since a nonducted exhaust system does not normally remove the heat from the exhausted air, additional air conditioning may be required.

XV. Make-up Air

- A. Each room provided with an exhaust system shall have supplied to the room an amount of filtered and tempered make-up air equal to the amount of air to be exhausted. If make-up air were not provided, the building would be under a negative pressure which could cause the following problems:
 - 1. The exhaust fan would not be capable of exhausting the design volume of air because the air would not be available.

2. Negative pressure would cause improper venting of water heaters, space heaters, or other individually vented gas appliances in the building.
 3. A negative pressure will cause a surge of unconditioned outside air into the building whenever the doors are opened, which may also allow the entrance of flies into the facility.
- B. In order to provide an efficient air exchange system, the following factors should be taken into consideration when evaluating a make-up air system:
1. The number and location of return air registers should be such as to provide uniform distribution of make-up air throughout the facility, taking into consideration cross drafts, room configurations, and required air flows.
 2. The use of properly designed registers and diffusers will help to slow down the air velocity and evenly distribute the make-up air.
 3. The make-up air registers should be located so as to prevent a short-circuiting of the air being supplied for the exhaust system.
- C. Windows and doors shall not be used for the purpose of providing make-up air.
- D. The exhaust and make-up air systems shall be connected by an electrical interlocking hardwired connector so that one system cannot be operated when the other system is off.
- E. Compensating hoods shall extract at least 20 percent of their required exhaust airflow from the kitchen area around the hood. Compensating hoods, that have been evaluated and listed, shall be sized and installed in accordance with the terms of their listing, and according to the manufacturer's instructions.

XVI. Fire Extinguishing Systems

- A. Approved automatic fire extinguishing systems shall be provided for the protection of commercial-type cooking equipment. The requirement for protection does not include equipment that does not create or generate grease-laden vapors, such as steam kettles and steam tables.
- B. Deep fat fryers, ranges, griddles, broilers, and other cooking equipment which may act as a source of ignition for grease in the hood, grease removal device, or duct, shall be protected by approved fire extinguishing equipment installed in accordance with the fire code adopted by the jurisdiction. Necessary approvals must be obtained from the local fire authorities prior to putting equipment into operation.
- C. The operation of any fire extinguishing system shall automatically shut off all sources of fuel and heat to all equipment requiring protection by an extinguishing system. Any gas appliance not requiring protection, but located under ventilating

equipment, shall also be shut-off. All shut-off devices shall be considered an integral part of the system, and shall function when the system is in operation. The automatic shut-off device must be manually resettable prior to fuel or power being restored.

- E. Exhaust hood fans shall continue to operate after the fire extinguishing system has been activated, unless fan shutdown is required by any component of the ventilation system, or by the design of the extinguishing system.

XVII. Ventilation Requirements for Special Cooking Equipment and Operations

A. Table-top cooking operations

Cooking equipment, which is located at customer dining tables, must be provided with approved mechanical exhaust ventilation. Korean barbecues and Japanese Teppan-style cooking typify these table-top cooking operations.

B. Table-side serving display operations

Traditional serving display operations, such as flambéing, may not be required to provide mechanical exhaust ventilation, unless excessive amounts of smoke, grease, steam, vapors, and/or heat are emitted. These serving display operations are not intended to cook the food, but merely "finish off" the product prior to serving. Local building and fire officials should be contacted for their requirements.

APPENDIX I

Installation Codes and Standards

Uniform Building Code	International Building Code
Uniform Fire Code	International Fire Code
Uniform Mechanical Code	International Mechanical Code
Uniform Plumbing Code	International Plumbing Code
International Fuel Gas Code	
National Electrical Code (NFPA 70)	
Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations (NFPA 96)	

Product Standards Used by Listing Agencies for Cooking System Components

- ANSI Z83.11, CGA 1.8 - Gas Food Service Equipment
- ANSI/NSF 2 – Food Service Equipment
- ANSI/NSF 4 – Commercial Cooking, Rethermalization and Hot Food Holding and Transport Equipment
- ASTM E814 – Fire Tests of Through Penetration Fire Stops
 - Backflow Protection for Grease Fire Suppression Systems
- ICBO AC101 – Grease Ducts, Flexible Enclosure Systems
- ICBO AC105 – Recirculating Commercial Kitchen Hoods
- ICBO AC121 – Grease Duct Systems, Self-Enclosed
- UL 197 – Commercial Electric Cooking Appliances
- UL 296 – Oil Burners
- UL 300 – Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas

- UL 710 – Exhaust Hoods for Commercial Cooking Equipment
- UL 762 – Power Ventilators for Restaurant Exhaust Appliances
- UL 795 –Commercial-Industrial Gas Heating Equipment
- UL 1046 – Grease Filters for Exhaust Ducts
- UL 1254 – Pre-Engineered Dry Chemical Extinguishing System Units
- UL 1479 – Fire Tests of Through Penetration Fire Stops
- UL 1570 – Fluorescent Light Fixtures
- UL 1571 – Incandescent Light Fixtures
- UL 1572 – High Intensity Discharge Fixtures

- UL 2162 – Wood-Fired Baking Ovens – Refractory Type
- UL 2221 – Fire Endurance Performance of Grease Duct Enclosure Assemblies Grease Ducts

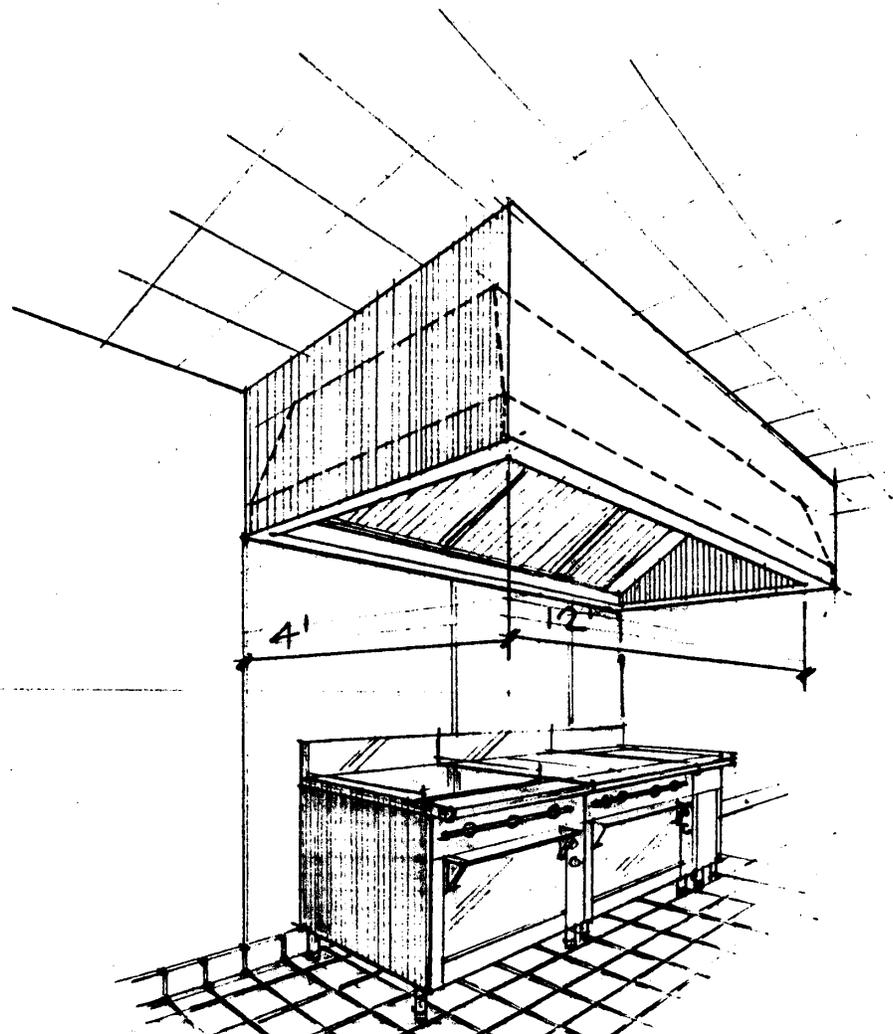


FIGURE 1

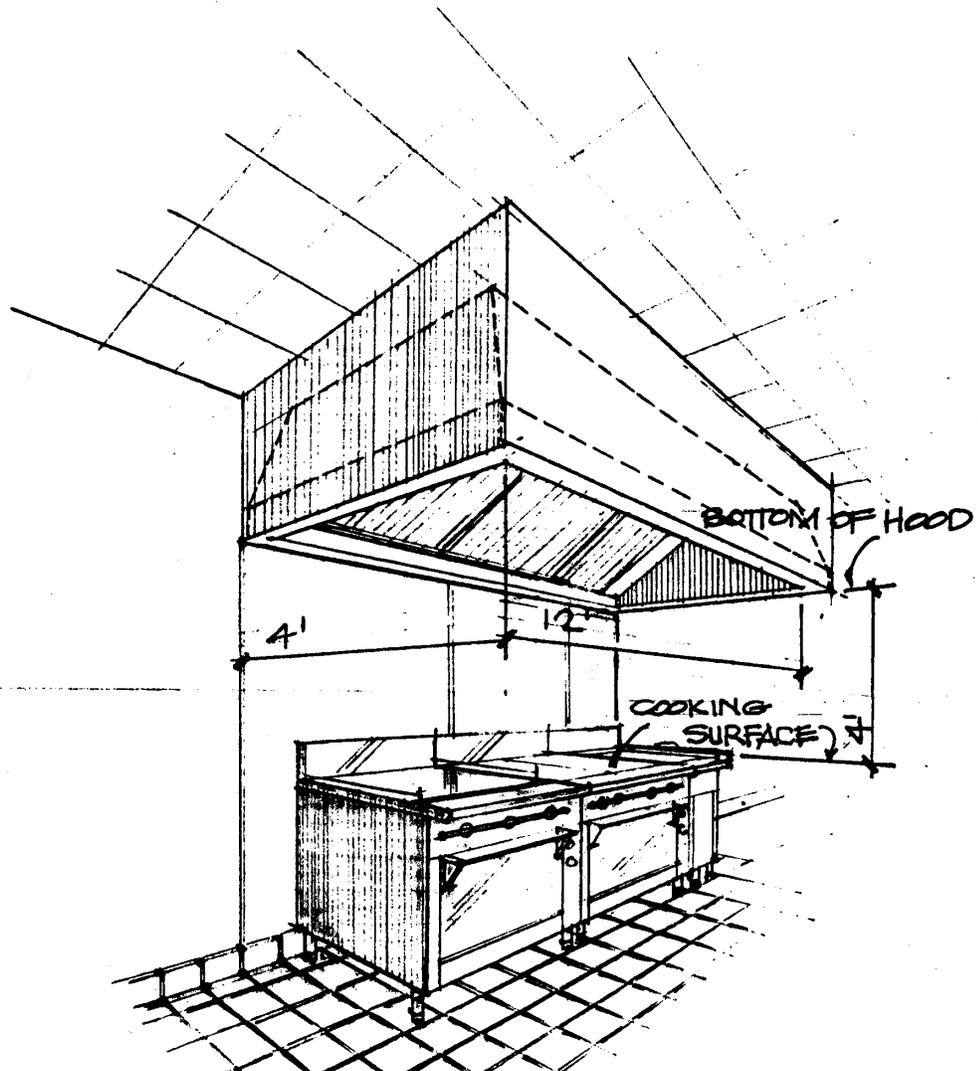
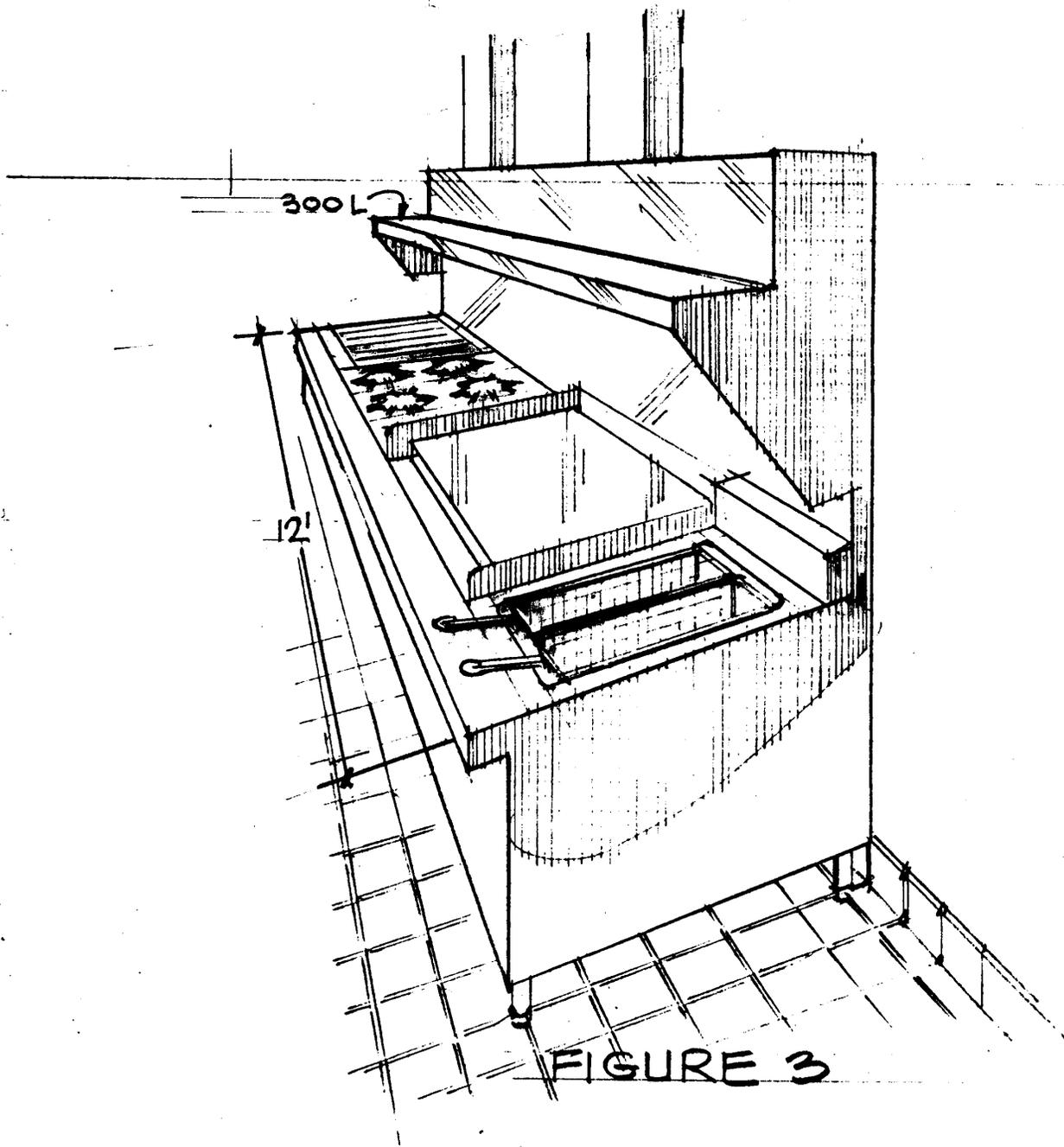


FIGURE 2



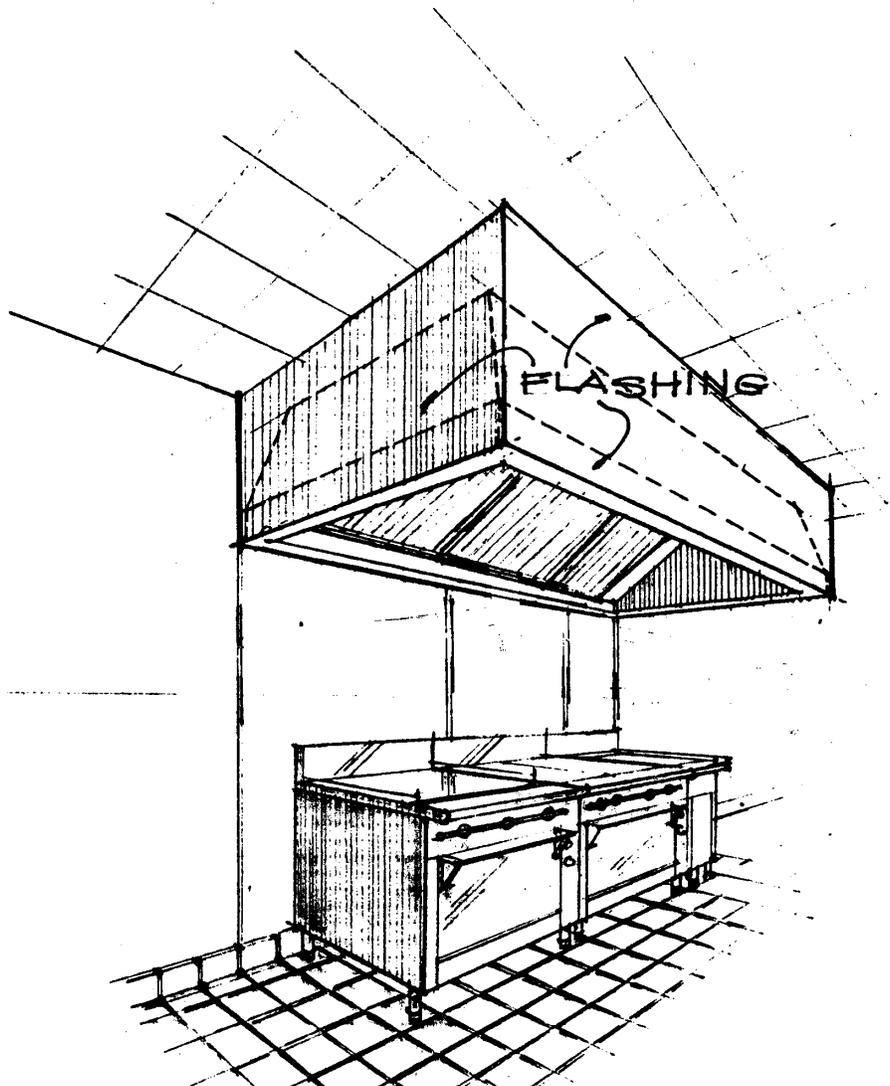


FIGURE 4

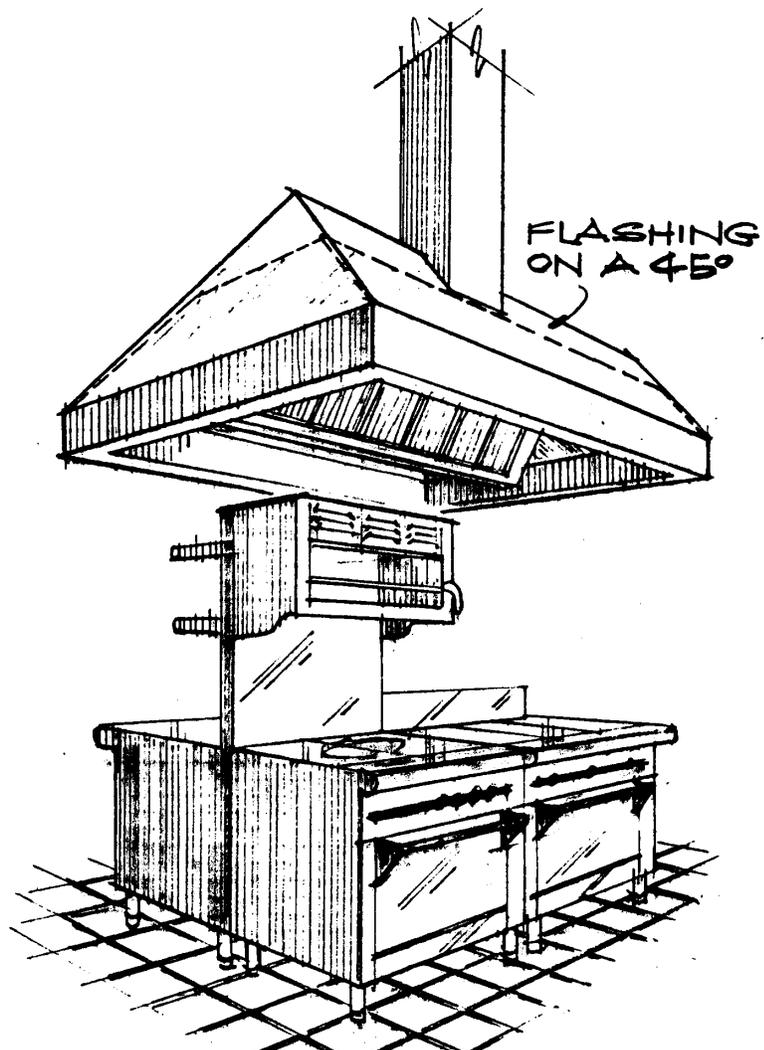


FIGURE 5

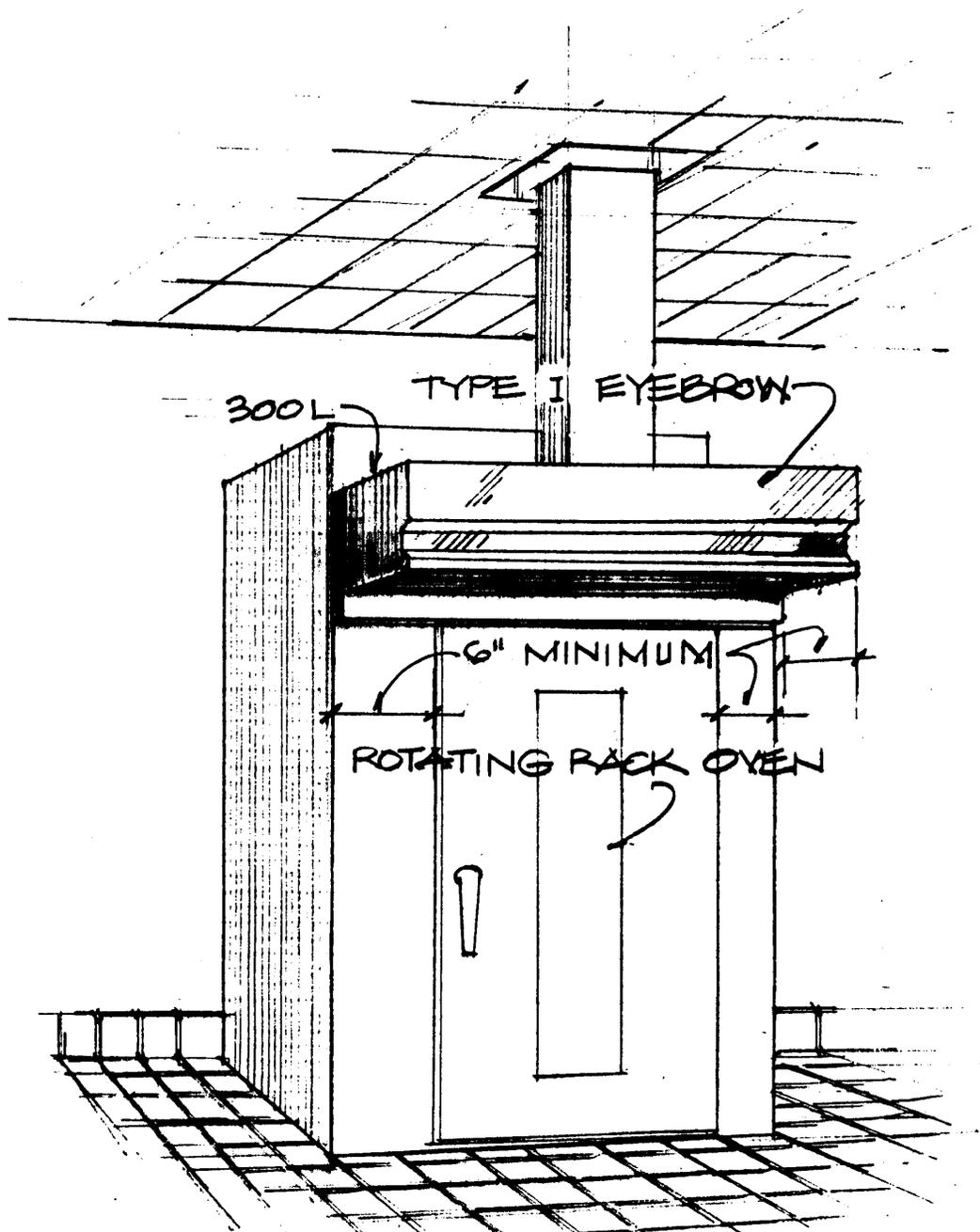


FIGURE 6

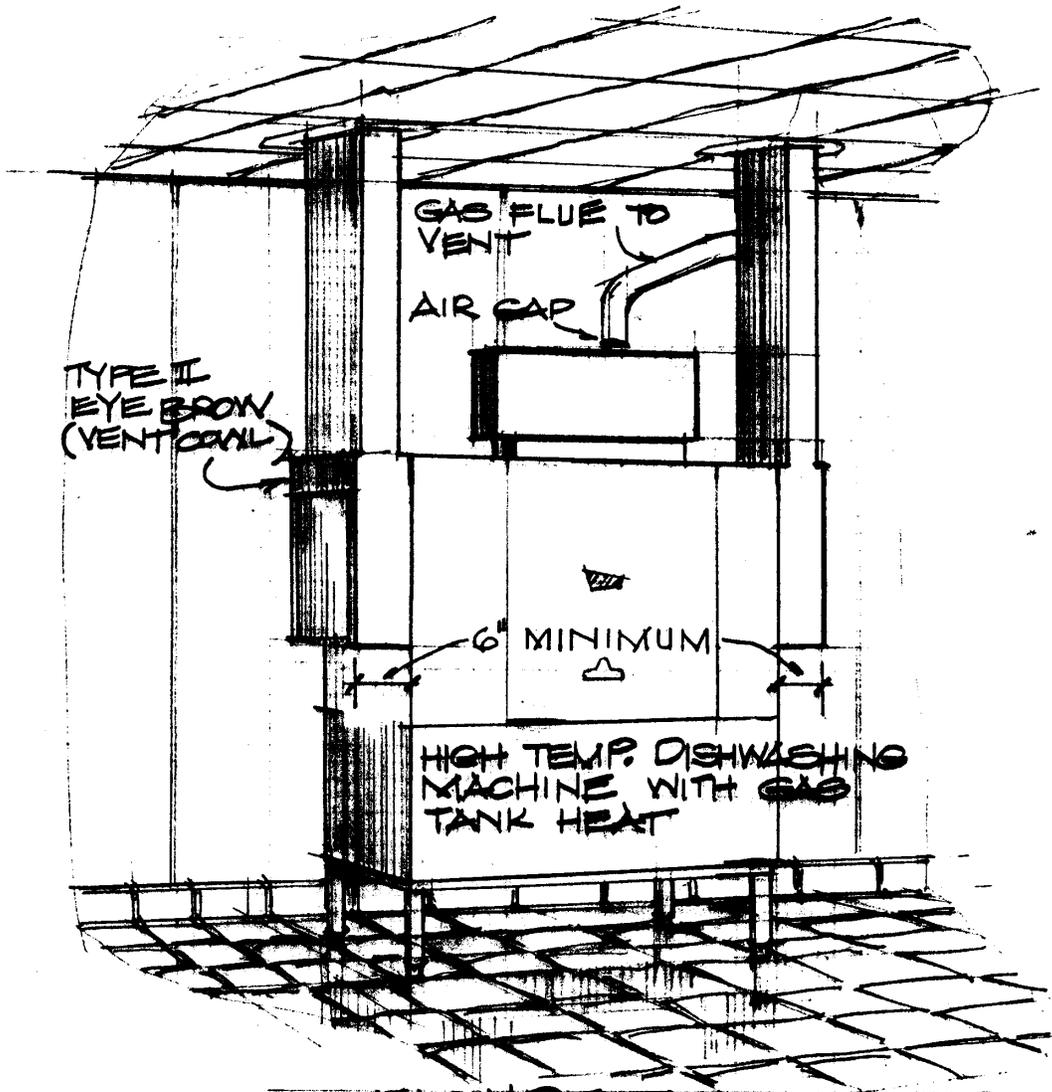


FIGURE 7